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The Smith-Manifold Caloulator

The Journal of Electricity

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

Vol., III, No. 4 San Francisco, October, 1896. { Yearly Subscription, $1.00 / Single Copies, - - 10 cents

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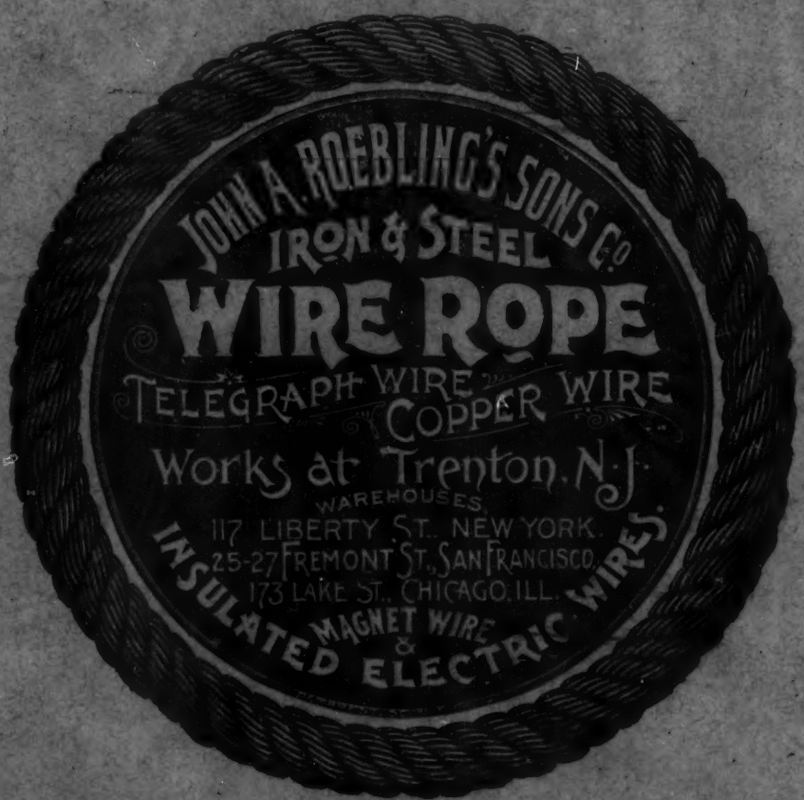

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The Journal of Electricity

Vol. III. OCTOBER 1896. No. 4

The Smith-Manifold Calculator

BY GEO. P. LOW.—Part II.

Most interesting and diversified are the uses to which the Smith-Manifold Calculator may be adapted, for in addition to the comprehensive list of problems previously given as being solved by it with the utmost facility, new applications for it come to the user almost daily. The mastering of its simple principles, or more particularly the practice that comes with persever.nce

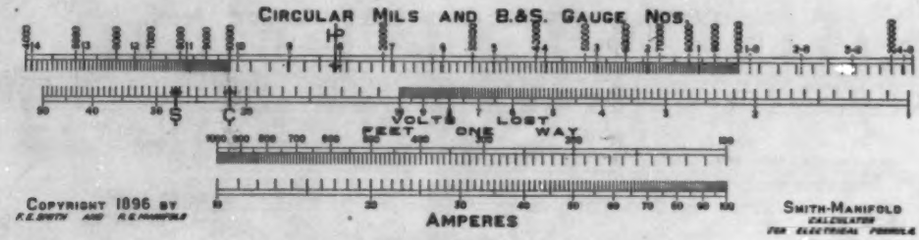

FIGURE 1—THE SMITH-MANIFOLD CALCULATOR

many other quaint yet most satisfactory uses. For instance:

in its use, gives rise to new ideas, each of which expands the sphere of usefulness of the Calculator. Not only is it indispensible as the perfection of wiring tables, formulae, and characteristics, and of hydraulic and electric power calculations, but it may be put to

Second example: A Thomson recording wattmeter having a constant of 1, and is measuring 30.2 amperes at 230 volts, required the number of revolutions per minute that the disc should make.

In solving the problem the Calculator is placed as number of revolutions required.

shown in Figure 3; that is, assume the figures on scale C, the "feet one way" scale, to represent volts, while the amperes are read on the ampere scale. Draw the slide to the left until 230 volts rests on 30.2 amperes. then under 600, on scale D, appears 11.6, which is the

No matter what may be the factors of the energy that the wattmeter is measuring, the number of revolutions will always appear under the 600 mark on the "Feet one way" scale, or scale C. Again,

Third example: A Thompson recording wattmeter with a constant of 1, takes 40 amperes from a 500-volt railway circuit; required the number of revolutions per minute the wattmeter disc should make.

Proceed as before, and as shown in Figure 2, the wattmeter disc should make 33 1-3 revolutions per

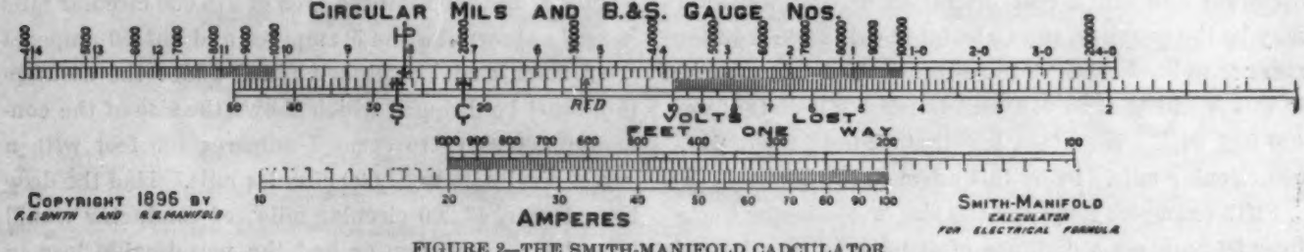

FIGURE 2—THE SMITH-MANIFOLD CADCULATOR

minute, for 33 1-3 appears under 600. Conversely,

Fourth example: A two wire wattmeter is cut in on a service supplying a certain consumer, and it is desired to know the current consumption, the potential of the service being known.

If the latter is, say, 110 volts, and the meter makes 16 3-5 revolutions per minute, proceed practically as

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in the two preceding examples, or in other words, adjust the slide of the Calculator, so that the mark for 16 2-3 (revolutions) appears directly under the 600 mark on scale C. It so happens in this case that the position to be found is the normal one of the Calculator as in Figure 1. Now under 110 (volts) on scale C, read 91 amperes, which is the current the wattmeter is measuring.

Clearly then, it is far more easy to look at a Smith-Manifold Calculator and read the ampereage therefrom after merely counting the number of revolutions the wattmeter disc is making than to go to the station for the Weston ammeter, to rig up a jumper so as not to interrupt the service, to cut in the ammeter, to take the reading and then undo all that has been done. If alternating current service is delivered, the leveling and calculation attending the use of a Siemens dynamometer will make one's misery complete, but he will have gotten the ampereage within an hour and a half even though the calculator will have given it in a minute and a half.

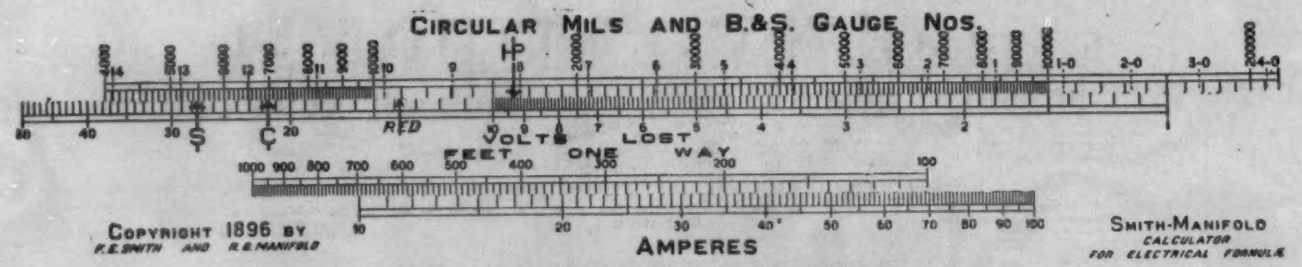


FIGURE 2—THE SMITH-MANIFOLD CALCULATOR

It will appear at the outset that the Calculator in itself is limited from 4,000 circular mils to 200,000 circular mils; from 1 to 50 volts loss; from 100 to 1,000 feet one way and from 10 to 100 amperes, but this is an apparent and not a real limitation in that whatever may be the problem, the Calculator will solve it in the manner to be shown. Following up the first example, it was found that to deliver 50 amperes a distance of 400 feet with 2 volts loss, required a conductor of 216,000 circular mils. From this advance to the:

Fifth example: Required the size of conductor to deliver 50 amperes a distance of 400 feet with a loss of 1 volt.

There are two different yet simple modes of solving the problem, in both of which the Calculator is set as in Figure 2. It is obvious that the size of wire required for volt loss must be twice that for two volts loss or ten times that for a loss of 10 volts. Apparently the result is not given directly on the Calculator for the reason that it is found upon inspection that with 1 volt loss the conductor must have an area of more than 200,000 circular mils—how much more is not shown. It was seen in the first example that a wire of 216,000 circular mils was required to give 2 volts loss, hence clearly, to give one volt loss the area of the conductor must be twice as much or 432,000 circular mils. The second mode is more accurate solely because of the greater legibility of Scale A for sizes below 100,000 circular mils and in this instance the mode consists of finding the size of wire necessary to give a loss of 10 volts and then multiplying the circular milage thus derived by 10. Use the same setting of the Scale and over the mark indicating a loss of 10 volts, it will be seen that for that drop a wire having an area of 43,200 circular mils must be used, hence for 1 volt loss its area must be ten times as great or 432,000 circular mils. Suppose now, another case is presented shown in the:

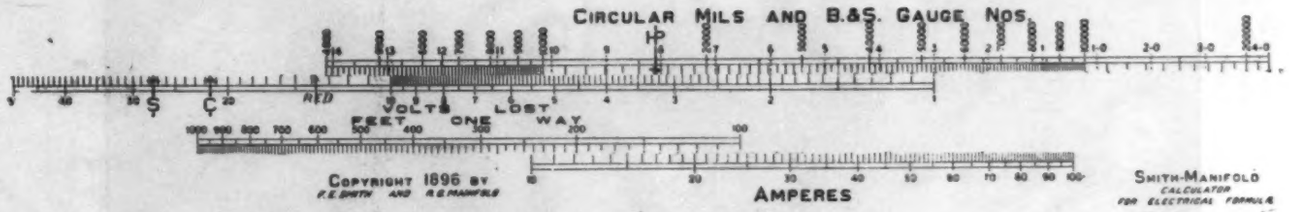
Sixth example: A loss of 2 volts is permitted on a lighting circuit carrying 5 amperes a distance of 400 feet; required the size of conductor?

The same method of reasoning is to be adhered to as was worked out in the preceding example, hence assume as before that the current is 50 (10 times 5) amperes, in which event the Calculator is placed as in Figure 2, and the required area of 216,000 circular mils is again shown, but as 5 amperes and not 50 amperes are transmitted, the cipher added under the assumption must be dropped which shows the size of the conductor necessary to carry 5 amperes 400 feet with a loss of 2 volts, to be 21,600 circular mils. Had the drop been 1 volt, 43,200 circular mils of conductor would have been necessary, or had the permissable loss in voltage been but one half a volt, 86,400 circular mils would have been necessary.

In brief, (1) add to the circular mils scale one cipher for each cipher assumed to be added to either factor appearing on the "feet one way" or the ampere scales; (2) drop from the circular mils scale one cipher for each cipher assumed to be dropped from either factor appearing on the "feet one way" or the ampere scales;

(3) add to or deduct from the number of ciphers given on the circular mils scale, as many ciphers as appear in the difference between the ciphers assumed to be added to or deducted from the "feet one way" and ampere scale, and finally bear in mind that (4) while the volts lost vary directly as the amperes carried and the distance (feet-one-way) traversed, they vary inversely as the circular milage or area of the conductor. To be still more explicit, the larger the ampereage, or the greater the distance, or both, the greater will be the loss or drop in volts over a given size of wire, in direct proportion to the increase of either or both factors, but the greater the circular milage the less will be the loss in volts with a given distance and ampereage.

A clear understanding of that which has been explained will be had from a study of the following schedule of miscellaneous wiring problems readily solved by setting the Calculator per Figure 2:



THE FIGURE 4—SMITH-MANIFOLD CALCULATOR

50	amperes,	400 ft., 2 volts loss,	216,000 C. M.	
50	"	40 ft., 2 volts loss,	21,600 C. M.	(2)
50	"	4 ft., 2 volts loss,	2,160 C. M.	(2)
50	"	4,000 ft., 2 volts loss,	2,160,000 C. M.	(1)
50	"	4,000 ft., 1 volt loss,	4,320,000 C. M.	(1) (4)
5	"	4,000 ft., 1 volt loss,	432,000 C. M.	(3)
5	"	400 ft., 2 volts loss,	21,600 C. M.	(2)
5	"	400 ft., 1 volt loss,	43,200 C. M.	(2) (4)
5	"	40 ft., 1 volt loss,	4,320 C. M.	(2) (4)
5	"	40 ft., 2 volts loss,	2,160 C. M.	(2)
500	"	400 ft., 2 volts loss,	2,160,000 C. M.	(1)
500	"	40 ft., 2 volts loss,	216,000 C. M.	(3)
500	"	40 ft., 1 volt loss,	432,000 C. M.	(3)

etc., etc., etc.

(To be continued.)

COMMENDS IT HIGHLY.

The success which the General Electric Company's long burning arc lamps is meeting from all sides is shown by the steady increase in the orders. In a recent letter from the Superintendent of an important station in Maine is the following: "We have used the lamps for eight months with exceedingly gratifying results. Our customers are as well pleased as we, as increasing orders for them testify. We can commend this lamp most highly to electric companies wishing a lever against gas, and in places where the ordinary arc or incandescents cannot be installed."

THE STEVENS INSTITUTE OF TECHNOLOGY.

A noteworthy event in the annals of technical education in the United States will be the forthcoming celebration of the 25th anniversary of the Stevens Institute of Technology, on the 18th and 19th of Febuary next. The festivities will consist of a banquet, at the Hotel Waldorf, New York, to which representative engineers and technical educators throughout the country will be invited. On the following day the Institute will be open for inspection, and the methods of instruction, together with the apparatus in the various laboratories will be explained. Not the least interesting feature of the exhibition will be the collection illustrating the work of the Alumni, and consisting of machinery, apparatus, drawings, etc., representing the product of their activity during the 25 years. The festivities also include a reception, tendered to the faculty, graduates and undergraduates, by Mrs. E. A. Stevens, widow of the founder of the Institute, at Castle Point, Hoboken; a Promenade Concert and Dance in the evening will conclude the celebration.

The Institute has always taken high rank by the late Edwin A. Stevens of Hoboken, N. J., and in 1870 the erection of a building was commenced by the trustees, Mrs. E. A. Stevens, Mr. S. Bayard Dod, and Mr. W. W. Shippen. Dr. Henry Morton, at that time Secretary of the Franklin Institute of Phildelphia, was tendered the presidency of the Institute, and gathered a faculty of eight members about him. To this number others have from time to time been added, as the work of the Institute increased, until at the present time the faculty includes twenty-two professors and instructors. The total number of student graduates is 675, and the number in attendance during recent years has been about 260 each year.

The Stevens Institute has always taken high rank among the institutions devoted to technical education in the United States, and its 25 years of successful effort is amply exemplified in the work accomplished by its graduates in all departments of mechanical and electrical engineering.

Hydraulics

OVERCOMING WATER SHOCK.

Probably no more serious difficulty than that known as water ramming or water shock has stood in the way of the perfect application of water power to high heads of water and the difficulties directly due thereto are manifested in the tremendous strain to which the pipe line is sometimes subjected and to the marked increase in pressure which naturally accompanies the checking or stopping of water flow in a pipe line. It is the latter which is the cause of the trouble that has been experienced heretofore in devising a governor for giving such control of water delivered to a wheel as will insure the delivery of a constant speed, but the governing of water wheels is now an accomplished fact, regardless of the conditions which exist, and as the difficulties which have been met in the use of water under high heads as a motive power, are of two forms as above outlined, there remains but the one of overcoming water shock to be surmounted.

FIGURE 1—A BREAK DUE TO WATER SHOCK

The phenomena of ram or shock in pipe lines has been observed by all and many devices have been suggested for effecting a protection for the pipe against bursting or other serious injuries, but so far none have been applicable to all conditions and few have been effective under any conditions. How serious the consequences attending ramming may be is well shown in the accompanying engraving (Fig. 1) from a portion of a 22-inch pipe line conveying water under high head and which, owing to inexcusable carelessness on the part of an employe in instantly closing the wheel-gate, burst in the manner shown. The walls of this pipe are of quarter-inch rolled steel and the aperture made in the broken pipe had the maximum dimensions of 16 inches by 22 inches. The characteristics of the break together with the manner in which it was repaired are clearly shown in the engraving, but the damage wrought was rendered greater by the collapse of fifteen lengths of wrought iron pipe from atmospheric shock. This wrought iron pipe was in the upper end of the pipe line considerably above the point where the actual break occured and at first thought it may appear singular to the layman that pipe which successfully withstands a water pressure of several hundred pounds should be broken or rather, crushed, by the atmospheric pressure of 15 pounds per square inch. It should be stated, however, that this atmospheric shock was due to the fact that when the break occured the weight of the column of water in the pipe line above it caused the water to rush out through the break at a far greater velocity than it was possible for the water to enter the intake at the head of the pipe line, thus causing the vacuum to be formed in the pipe line which, though capable of withstanding an internal pressure of several hundred pounds, is not by reason of its construction of sufficient rigidity to withstand the low external atmospheric pressure—being of 7 pounds per square inch,—as developed by a vacuum within the pipe.

The illustration presented is that of an extreme case which, though an actual occurrence, carries with it an idea of the one remaining difficulty attending the use of water under high head. It can not be said that experience has demonstrated the success of relief valves as a means of preventing the evils of water shock. Greater success has been attended by the application of an air chamber of suitable dimensions and such chamber gives to a pipe line an elasticity to resist shock which is not obtainable with any other known device and so far as receiving and absorbing the shock

per se is concerned, probably no better device will be forthcoming.

But where the flow of water in the pipe line is used to drive water wheels and when the quantity of flow is regulated by increasing or diminishing the area of cross section of the nozzle, the use of an air chamber has presented some difficulty.

Messrs. Cobb & Hesselmeyer, mechanical and hydraulic engineers of San Francisco and who have brought out a new device for preventing fluctuations of pressure due to water shock, point out some of the difficulties attending the use of an air chamber under the conditions given. In illustrating the case, they consider a pipe line flowing full of water at a normal velocity under a given pressure and discharging through an orifice of variable cross-section. It is assumed that this pipe line is provided with an air chamber placed at a point preferably near the point of discharge; suppose that the cross-section of the discharge orifice be suddenly decreased, then the normal velocity of flow in the pipe line must be as suddenly checked, and the excess energy of the moving mass will be spent in, first: compressing to a greater degree the air confined in the air chamber; and, second; in giving an increased velocity of flow through the reduced discharge area.

The air in the air chamber thus compressed above its normal pressure will react and cause a return flow or rebound of water in the pipe line, the energy of which will be as great as the original excess energy of flow, less the loss due to friction, and this alternate flow and rebound will continue in action until friction has absorbed the excess energy of the moving mass. The alternate flow and rebound above referred to, cause coincident increase and decrease of velocity of flow at the discharge orifice, and render the attainment of uniform speed in the water wheel a matter of uncertainity.

The water which enters the air chamber during the compression of the air therein is discharged through a suitable waste valve at the side, this valve being opened by the excess of pressure above normal as entrapped in the air chamber, and closes automatically when the water discharging from the air chamber has reduced the pressure therein down to normal conditions.

It will be observed that under this arrangement:—first, only that amount of water is wasted which is passed through the air chamber as an exact measure of the energy of the rams overcome.

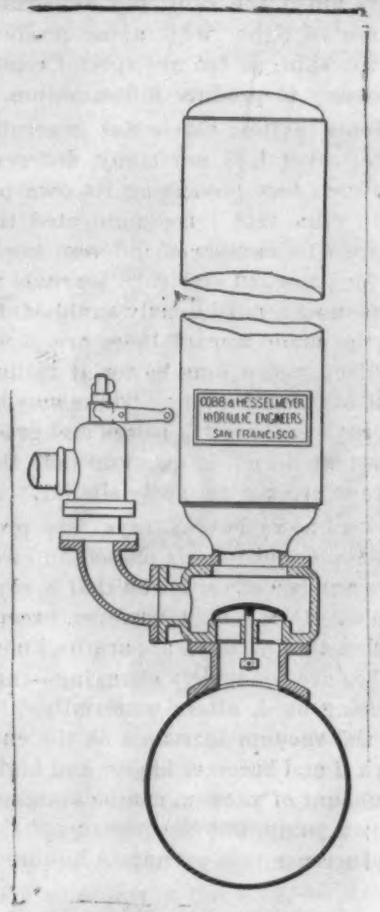


FIGURE 2—RELIEVING THE REBOUND OF AN AIR CHAMBER.

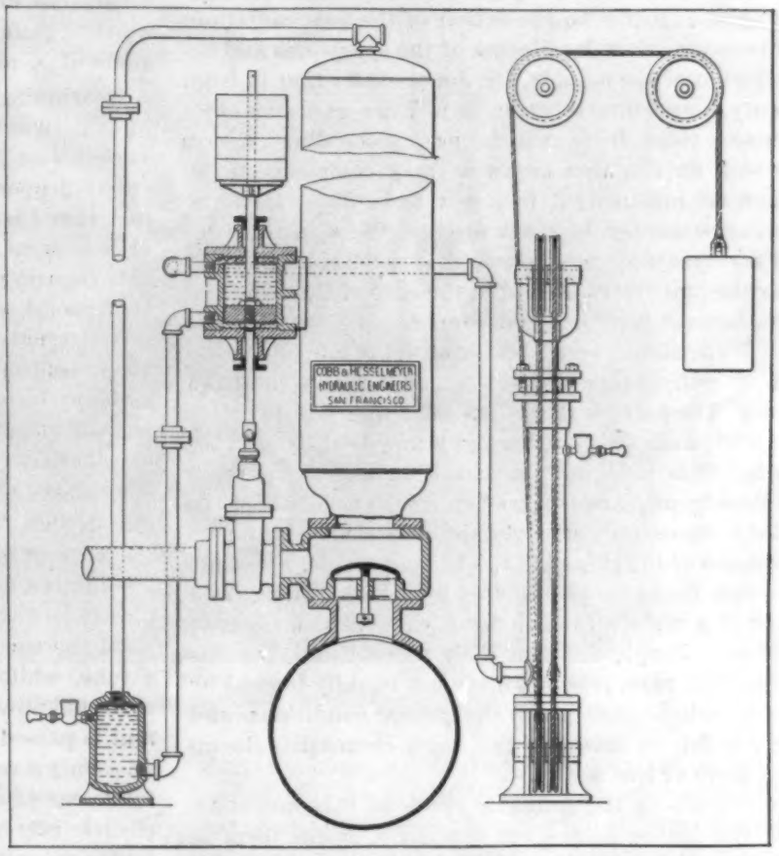


FIGURE 3—ARRANGEMENT FOR AN EXCEPTIONALLY CLOSE REGULATION

Second, that under normal conditions, the pressures the automatic stop valve between air chamber and pipe is in balance.

Third, that in most situations, the simple arrangement shown in Figure 2 may be used, as the confined, non-fluctuating, excess pressure in the air-chamber is an ideal medium to operate a safety valve as there shown.

Fourth, that if an exceptionally close regulation of pressure in the pipe line is desired, the arrangement shown in Figure 3 may be used, wherein the discharge valve from the air chamber is operated by an hydraulic cylinder, the piston of which receives on one of its faces the pressure of the air-chamber, and on its opposite face a constant pressure from the accumulator shown, exactly equal to the normal working pressure of the pine line.

Electro-Therapeuty

HOW AND WHY X-RAYS BURN.

In pointing out the serious effects of over-exposure to Roentgen rays, Dr. Philip Mills Jones states through a contribution to the San Francisco Examiner, that when Professor Roentgen announced his discovery, the fact that the bones of the skeleton could be examined without removing the coverings of skin and muscle was sufficiently startling to awaken universal interest —markedly so in the case of medical men.

As the apparatus used became better understood and improvements were made, reports came from different parts of the country of various casualties following upon exposure to the action of the new radiation.

Proceeding to a description of the symptoms and development of the malady, Dr. Jones states that in from twenty four hours to seven days after exposure to a vacuum tube from which are proceeding X-rays the skin on the area exposed may commence to be somewhat inflamed; it feels hot and itches; then the burning sensation becomes intense, the skin puffs up and is very sensitive—sometimes it turns almost black: later the hair falls out, and in the case of the hand the nails become very red and sore, and finally are cast off. If the skin is scratched or struck while in the second, or puffy stage blisters followed by suppuration ensue. The process slowly subsides, the skin becomes dry, scaly and peels off, leaving a new healthy skin beneath. This inflammation has been named "Dematitis Roentgenii," and is a true gangrene, or death, of the skin; it necessarily involves similar changes in the appendages of the skin—i.e., the hair and nails. These unpleasant effects are caused only by X rays coming from tubes in a certain condition, which will be spoken of later on. People differ in their susceptibility to this action of X rays, just as all are not equally burned by direct sunlight; but given the proper conditions, and it is possible to induce in any one a Dermatitis Roentgenii more or less severe.

In describing the probable cause of this inflammation, the author points out that light is one form of energy—a form of what is called radiant energy—and can do work just as any other sort of energy. When a ray of light falls upon a molecule in the emulsion on a photographic plate, the ray is said to be "absorbed," its energy is expended in changing the construction of the molecule. If the plate is now treated with certain chemicals it will be found that the change effected by the energy of the ray of light has made such a change in the molecule by which it was absorbed as to make that molecule possess entirely different properties from the others. If enough molecules have been affected, the result will be quite perceptible to the eye. Roentgen rays act, so far as their results are concerned, in precisely the same manner. When the X rays fall upon a sensitive plate some of them are absorbed by the molecule in the emulsion and the arrangement of the molecules changed, precisely as it would be changed by light. Consequently we know that the X rays are a form of radiant energy and that they do work, though just what sort of radiant energy we do not know. We know that electricity will do work, but we do not know what electricityis.

In the same way, when sunlight falls on the skin, it affects the molecules, rearranges them and produces noticeable changes. The light energy is mostly expended in heating the surface exposed—we stand in the the sun to get warm—but some of it is absorbed by the molecules and produces "tan" or "sunburn," and this last may be so extensive as to result in serious inflammation, blistering, suppuration, etc. So will exposure to the X rays affect the skin; but as certain conditions of exposure to light will alone produce marked changes in the skin, so too are special conditions of X rays necessary to produce inflammation.

Continuing, Dr. Jones writes: "It is not generally known that there are several, if not many, different varieties of X rays, each sort possessing its own peculiar properties. In June last I communicated the fact that I had discovered a number of different kinds of X rays to one of the principal electrical journals in this country, and was most ignominiously snubbed. In the last number of the same journal there are three articles on that subject, and a long editorial calling attention to the value of this discovery. There may be as many forms of X rays as there are colors and graduations of light; as yet we do not know more than the one fact that all X rays are not precisely similar.

"Probably every one knows how X rays are pro; duced; that through a vacuum tube is passed an electric current of a large number of volts, and that X rays are emitted by the tube. Few people, however, except those who have experimented with the apparatus, know that the vacuum tubes are constantly changing—that a tube, while it is being used, alters materially. In some unknown way the vacuum increases as the current is passed through it and becomes higher and higher. Only a certain amount of vacuum can be obtained by means of any known pump, but the passage of the electric current may increase this vacuum a hundredfold.

"As the condition of the vacuum changes, so the characteristics of the X rays which come from it change. These changes and differences can be recognized only after long and careful observation of many tubes, but when once thoroughly known the exact nature and peculiarities of the rays coming from any given tube can be recognized at a glance. Generally when the tube is new and is first used the X rays emitted are in considerable quantity, but are easily absorbed. They affect a plate profoundly, but will not go through the flesh of the hand to any extent—they have no penetrative power. As the vacuum increases the character of the rays changes, then increase in penetrative power and are less readily absorbed; consequently they affect the sensitive plate and the skin less than under the former conditions. By carefully study-

ing the phenomena of tubes, therefore, it is quite possible to make exposures to the action of X rays without anticipating any untoward consequences. Aided by this fact, I have made hundreds of exposures without a single casualty. I am at present working on some experiments to ascertain whether there is any effect on the deeper structures, bones, etc.—resulting from absorption of the rays. Thus far, however, the changes I have been able to observe have been purely superficial.

"Dr. Martin Regensberger, whose opinion on skin disturbances is worth considering, says that the inflammation caused by Roentgen rays is a true gangrene or death of the cells, and that this could easily be accounted for by a chemical change in the molecules, caused by the expended energy of feeble rays. As all that class of X rays which have but little penetrative power would be stopped by the skin and absorbed by the molecules in the skin, we should naturally expect to see most of the trouble confined to those tissues.

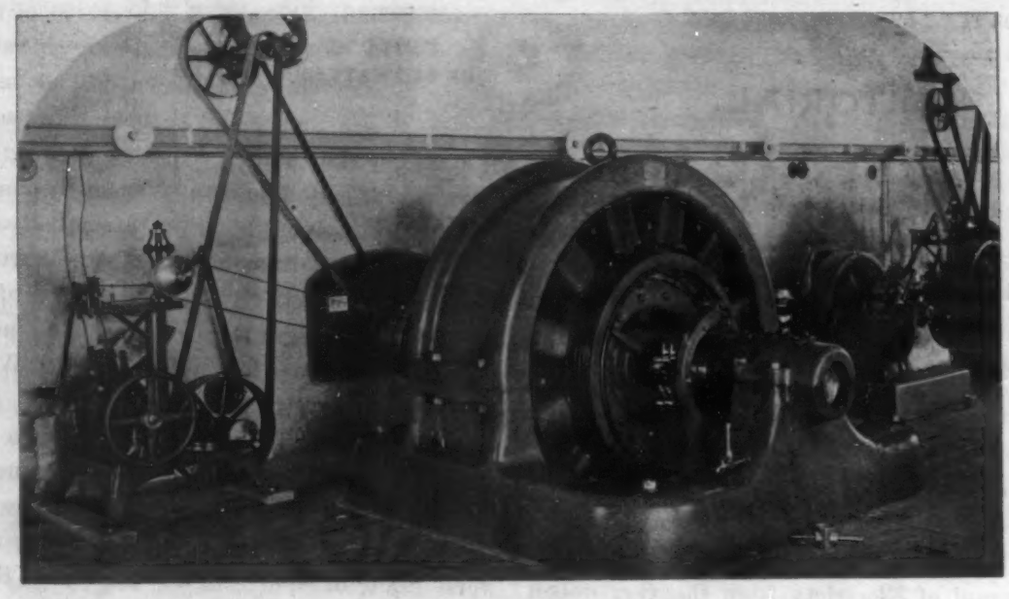
"We find, then, that X rays of a certain sort are absorbed very readily by the molecules of the skin; that these rays so change the chemical nature of the molecules that the cells die and gangrene of the skin results, but that as all X rays do not act in this way it is not necessary for every exposure to them to be followed by inflammation of the skin. Roentgen rays may be, in careless hands, both harmful and dangerous; but used with skill and in the light of experience, they are free from danger and of great benefit."

The light of the starry sky has been found by Captain Abney to be about 1-44 that of the full moon, which is placed at 1-600,000 that of the sun at noon.

Transmission

REPOGLE GOVERNORS IN THE FRESNO PLANT.

The only material alteration that has been made in the transmission plant of the San Joaquin Electric Company of Fresno, Cal., since the description of the installation appearing in the April number of the Journal, has been in changing the water wheel governors as described previously to the ones appearing in photographic reproduction on this page. The well known Replogle governor, which has been freely described in the technical press of late, is now used exclusively and so satisfactory is its operation that Mr. J. S. Eastwood, Vice President and General Manager of the company, is authority for the statement that the regulator keeps the speed within two per cent of normal at all times, even when the 150 kilowatt synchronous motor driving the Sperry Flouring mills, is thrown on to the circuit.



REPOGLE GOVERNORS IN THE FRESNO TRANSMISSION PLANT

INGENIOUS, AT LEAST.

A fruitful cause of collisions at sea during fogs is to be found in the difficulty experienced in locating the position of foghorns, sirens and other sonorous signals. One of the devises lately brought out for removing this danger consists in two microphones, one in the bow and the other in the stern of the vessel. The bow microphone is connected with a telephone placed at the right ear, and the stern microphone with another at the left ear of the observer, who otherwise is isolated from the sound of the signal. Taking the speed of the sound and the time it takes to travel the length of the ship, the observer can estimate the direction of the fog signal. When both sounds are simultaneous the signal is at the right angles to the vessel.

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EDITORIAL.

A WORD ABOUT THE JOURNAL

The lateness with which this publication is making its appearance has brought out such universal expressions of regret from every quarters as to emphasize the esteem in which it is held and to establish beyond doubt the necessity for its continuance. And continued it shall be.

A word then in mitigation of the offence it has committed against the unwritten ethics of journalism. No mistake has been made in matters of style and of policy. The Journal of Electricty from the very outset has been in true accord with the ideas and desires of its readers; its patrons have been from the East and from the West; its subscribers are found in all quarters of the globe from the Dominion of Canada to Guatemala, from London to Hai Phong. It is welcomed in every country as the magazine in which is recorded the progress of practical engineering development in the Far West,—its superiority in many features has been lauded by its readers and the technical press at home and abroad. Commercially it has from the very outset, and is even yet, a paying property.

What then, can be said in defense of its lateness of issue, which is its only short coming? The time was ripe for a first class electrical periodical when the Journal was instituted, as its success attests, but in truth it must be said that the Journal was then hardly ripe for the time in that its proprietor had other matters in hand which, though quite unforseen, so developed in importance as to demand his entire attention to the exclusion of the business of the Journal. Deplorable as was this neglect, it can only be said in extenuation that it was unavoidable. Relief has at last come; all matters outside of the Journal have been finally disposed of and today the proprietor finds himself free to prosecute the interests of his paper to the exclusion of all other affairs.

Most sincere and grateful appreciation is felt toward those whose fidelity to the Journal has led them to patiently endure its tardiness and to remain steadfast in its support during these, its days of trial.

CONSERVING POWER ON RAILWAYS

Periodically there appears some genius who aspires to fame and fortune through the invention of a device for conserving the energy of railway trains in going down hill or in coming to stops and in turning to useful account the energy thus stored. The latest to bring out such a scheme is a Buffalo man, Warner by name, who proposes to attach, as he says, "a small dynamo to the axles of steam cars so that when they are running down hill enough electricity will be generated to carry a train up the grade, or to take most of the pull from the locomotive." Mr. Warner has experimented with his models, and although he had no locomotive, he is reported to have found by a register attached to "a pulling contrivance" that the electricity generated going down one hill was sufficient to equalize the resistance occasioned by a heavy adverse grade of equal length. He thinks that the saving of coal alone and the increased capacity of locomotives would more than pay any big railroad company for the expense of equipping their coaches with the devise in less than a year.

Every one who has noted the condition of the brake shoes of the cars of a railway train that decends a mountain grade, or who has figured on the terrific momentum of a moving train, must have been impressed with the waste of energy that is ever occuring with consequent losses of power in all railway systems. Roughly speaking, were it possible to determine the amount of coal consumed in starting a given train and in pulling it up a given grade, some idea might thus be formed of the power that is wasted in the form of heat developed by the brakes in taking the train down the grade and bringing it to a standstill. The fascination of saving this power by electrical means has allured inventors but those of broader experience have thus far failed to devise a commercially feasible

scheme for attaining the end that has long been sought for.

Without inviting the complications which the intricacies of heavy railway trains makes necessary, the operation of street railway cars affords most advantageous opportunities for the perfection of the idea. They are, for instance, already equipped with motors (or dynamos) on their axles; the fields of these dynamos may be charged to any desired point of saturation from the trolley circuit giving the perfect means of a separately excited dynamo for securing a maximum armature effort or output; the cars are electrically connected to other cars through the trolley wire and rails; oftimes electric roads are run through territories covering many heavy but short grades and the frequency of service on such lines makes it probable that while certain cars are going down a grade other cars will be ascending grades. Despite these advantages and the fact that the ablest electrical inventors in this country have grappled with the problem, practically no advance has been made and the energy of the descending car is lost as it has ever been.

No effort is being made to depreciate the importance of conserving the power thus wasted particularly on steam lines. Unquestionably it is there and unquestionably it will eventually be made available but it will not be through the use of a dynamo delivering electricity to a storage battery of the present form Far more rational than this would be the accumulation of power by compressed air, filling receivers to a high pressure and conveying the energy thus accumulated to the locomotive, whence it will be delivered to the cylinders after having been reheated in the fire box. The efficiency of such a system would be very high and the apparatus employed would be inexpensive as to first cost and maintenance. Compressors could be placed under each car and in the air pipe to the engine as with air brakes and receivers of small dimensions could be located on the engine or tender. At the Presidio the Rix air compressors delivered air to receivers at a pressure of 2000 lbs. to the square inch, and there would seem to be nothing to prevent the delivery of an equal pressure to receivers placed on a locomotive. This being done there is nothing to prevent the delivery of heated air to the boiler or cylinders at boiler preassure through the use of pressure reducing valves, and the energy thus delivered certainly means the saving of coal in direct ratio to the power accumluated.

Literature.

Any Book Published Mailed upon Receipt of Price by The Journal of Electricity.

A PRACTICAL TREATISE ON COMPRESSED AIR AND PNEUMATIC MACHINERY: By Edward A. Rix and A. E. Chodzko, Pneumatic Engineers for the Fulton Engineering and Shipbuilding Works. About 500 pp., bound in flexible leather with gilt edges.

This is the title of a recently issued book, which, while it illustrates machinery designed by Mr. Rix and manufactured by the Fulton Iron and Shipbuilding Works, of San Francisco, is certainly much more than a trade catalogue; for it treats of the underlying principles of the production and use of compressed air in a concise and most masterly way.

The use of compressed air is not new, but the field of its usefulness has extended very rapidly of late because engineers are coming to realize its peculiar fitness for certain conditions. A striking example of this fitness is given in the beginning of the text of this book. Briefly this is as follows: A number of years ago a mine was to be equipped with a power plant. There was an ample water power several miles away, but neither the water nor the mechanical energy could be transmitted to the mine. Wood for fuel was plentiful and cheap. A first class steam plant was put in. After a time fuel became scarce and expensive, and a change became necessary. An electric transmission from the available water-fall would leave the steam plant valueless. But an air compressing plant at the water-fall could furnish compressed air through pipes to run the engines which had previously used steam. The boilers would serve for reservoirs or heaters. In case of a break down of the compressing plant, the compressed air connection could be shut off and the steam plant could be used as before. Independently then of the actual relative efficiency of the electrical and compressed air transmission, the latter is better fitted for this place. Incidentally this example also brings out clearly the necessity for the treatment of modern engineering problems individually, with careful study of all modifying conditions.

Following this is a treatment of the thermo-dynamics of compressed air. The authors are to be congratulated upon the accuracy, completeness and conciseness of this treatment and upon the omission of unnecessary mathematical analysis. The modification of theory by practical considerations, such as loss of pressure in passage through long pipes and through bends, the influence of difference of level, etc., are clearly treated. Then follow the explanations of the use of compressed air for refrigeration and in engines for the development of power. The first part concludes with the solution of several problems in detail of compressed air transmissions.

Two very valuable features of the work are, the

introduction of many numerical examples with the solutions in full, and of tables and graphical diagrams worked up from the best available experimental data. These cannot fail to be of great use to the engineer who has to deal with problems involving the use of compressed air. The book is not only a very valuable contribution to the literature on the subject, but it stands alone as the only exhaustive handbook which has been published for the information and guidance of the pneumatic engineer.

Bulletins of the University of Wisconsin, Engineering Series.

Emergencies in Railroad Work, by L. F. Loree, 40 pp., 35c.

Railway Signalling, by W. McGrafton, 35 pp., 35c..

The Problem of Heat, Light and Power Supply, for Building Blocks, School Houses, Dwellings, etc., by G. Adolph Gertzen, 60 pp., 45c.

A Complete Test of Modern American Transformers of Moderate Capacity, by A. H. Ford, 88 pp., 35c.

The Bulletins of the University of Wisconsin from which we have selected four for our notice, consist of lectures delivered by special engineers conversant with the particular problems treated and delivered before the different engineering departments of the University. Being generally delivered by practical men and not practical educators the pamphlets contain a great deal of definite information collected through many years of actual service and are in consequence of great interest and value to engineers interested in these special subjects. Mr. Loree, who writes on Emergencies in Railroad Work presents the results of many years' experience with divisions of the Pennsylvania Railroad having headquarters about Pittsburg. After reviewing his experience in clearing general wrecks and very clearly specifying the proper equipment for a wrecking train, he gives the results obtained from such an equipment during five years of service. Following this general section a description of the reconstruction of the Pennsylvania Railroad in order to quickly renew communication after the Johnstown flood is given. The concluding portion is devoted to the part taken by the railroad wrecking service during the strikes of 1894, giving a graphic account of the methods used to maintain communication with Chicago during that difficult period. The whole paper gives an impression of the wonderful efficiency of the Pennsylvania Railroad wrecking department and emphasises the necessity of establishing such a department in order to maintain uninterrupted travel.

The second paper on "Railroad Signalling" explains the block and interlocking systems in use from an engineers standpoint, leaving the methods of handling the signals and switches, by electric, hydraulic or pneumatic power, to the specialists in each department; the discussion being devoted to the efficiency of the various systems employed from the standpoint of an operating engineer, although as we have said, the author expresses no opinion concerning the various systems of operating the various systems of signals from signal towers. We would judge from his statements that the electric automatic railroad signals and blocking systems are unreliable and not equal in efficiency to manual service.

In the third Bulletin Mr. Gerdtzen appears as an advocate of fuel gas as a means for heating and furnishing light and power to building blocks. His conclusions may, however, be easily criticised on the score of incomplete details concerning total cost and maintenance of the different systems, no clear comparisons being made of various plants in operation. In the first pages of his pamphlet he disposes of the claims made by the advocates of electric heating systems by showing that 770 horse power in engines and dynamos must be installed in order to furnish the heat which might be delivered by a 50 horse power boiler, used direct and where a large volume of air must be continuously heated, there can be no criticism of his deductions. In heating for three or four hours per day, a problem which is often presented in our climate, a higher efficiency could be obtained from electric heating and it will compare more favorably with a steam boiler that must necessarily be wasteful of coal during the stand by periods; at the same time we believe that electric heating apparatus will scarcely present an economy under such circumstances even though it be that the present systems are comparatively wasteful, and we believe that the installation of large electric heating systems can only be contemplated where the question of repairs becomes more important than the actual consumption of coal. In this essay a comparison of the cost of transmission using gas and electricity is made and the results given decidedly favor the use of gas though the question of generation is not sufficiently considered for a complete comparison. The pamphlet may, however, be advantageously consulted by any one desirous of knowing the results that have been obtained in the transmission of gas both through short distances by the ordinary pressures and over considerable distances with pressures of 600 pounds per square inch. The efficiency of heating by gas stoves, firing boilers with gas, the economy of gas engines and the most improved methods of gas lighting are all here well treated and one would rely upon his data concerning the use of gas rather than upon the conclusions drawn in comparing gas with steam and electricity on account of the fact that the treatment of the two latter does not include all of the points in question.

In the "Complete Test of Modern American Transformers" made by Mr. Ford we would first criticise the form of report given on account of the fact that it is impossible to determine the make of the transformers giving the record as no less than twenty-one transformers varying in capacity from 450 to 1,000 watts were tested, comprising all except two of the modern

American makes. The efficiencies vary most decidedly and were the names of the different transformers given, valuable data to installing engineers might be obtained from the tests, but as such names are suppressed the work remains to be done again by some one willing to give unprejudiced facts concerning the apparatus available in the electrical market. The results of these tests were given by Prof. Jackson in his paper before the North Western Electrical Association in July, 1895. Indeed one of the most valuable parts of this paper consists in a standard set of specifications proposed by Professor Jackson. It is further interesting to note that most of the transformers tested would conform to these standard specifications and also that considerable improvement is shown by American transformers over the English transformers tested by Dr. Fleming in 1892. Another part of the paper that strikes us as being valuable consists of a description of the testing methods employed and the calibration curves given for the various instruments used which show that although good ammeters, voltmeters and wattmeters can be generally relied upon, correction factors must be introduced in order to obtain the best results. This cannot be too carefully observed by engineers who are too apt to rely upon the original calibration which even in the best instruments is susceptible of some change. The methods of testing are ones that are easy to follow by practical engineers and it is to be hoped that this series of tests may be repeated and the results published without any suppression of data necessary to useful information.

ELECTRICITY NEAR THE NORTH POLE.

It is well known that electricty was used for illuminating purposes on the Fram in the Polar Expedition. Some account of this method is given in a Norwegian paper, which states that general regret was when in May, 1895, it was decided that electricity must be dispensed with, owing partly to the wearing out of the gearing of the cog-wheel in the windmill which worked the dynamo, after the vessel had entered the ice, and partly to the fact that portions of the apparatus were required for making snow shoes and runners. Mr. Nordahl took advantage of every puff of wind to load the accumulators, so that they were kept continually charged, and until May of last year the electric light was always available. In the severe cold the accumulators froze through, but the acid-blended ice proved an excellent electrolyte, and the frost did not interfere with the working of the accumulators. On festive occasions Nordahl suspended an arc lamp in the saloon, which gave such an excellent light that Dr. Nansen frequently used it when painting or photographing. When the two explorers left the ship, the arc lamp was run up to the top of the mainmast as a farewell greeting. The rigging was so thickly coated with ice that it had to be broken to pieces before the lamp could be fastened to the ratlines. Electricity was also used for other purposes besides lighting, the mining shots which set the Fram free from the grip of the ice being fired by means of a cable attached to six Leclanche cells. The entire electric installation worked admirably.

Physics

HEAT ENGINES AND CARBON BATTERIES.

The triumph of the steam engine over all other generators of motive power is one of the most marked revolutions of the century. Many other motives have been tried, and we frequently read in our daily papers, of wonderful inventions that are destined to overturn all of our industries, and relegate the steam engine to the scrap heap. The hot-air engine, for example, promised very well; but it has not fulfilled its promise, and although it is often quite serviceable where a small amount of power is needed, it has never been in any sense a rival of steam. Motors using the vapors of ammonia, ether, carbon disulphide, and other volative substances, have fared even worse; and thermo-electric batteries, pyromagnetic generators, and other such devices, have never been found to be of any practical use. In spite of the discouraging failures of these various contrivances, inventors are still busy at the problem. Its solution, we think, is bound to come. Man seldom invents a thing that cannot be replaced by something better; and it would be strange indeed if the steam engine proved to be the last product of inventive genius —a device to be improved, indeed, but not to be supplanted.

The trouble with most of the inventors who are seeking for a better motive power is, that they do not know the fundamental laws that underlie the heat-engine. These laws are only two in number, but one of them, unfortunately, cannot be fully understood without a considerable knowledge of mathematics. The first law governing the action of heat-engines—known as the "first law of thermodynamics"—is the familiar one which declares that heat and mechanical energy are mutually convertible, 780 foot-pounds of work (or there about) being equivalent to one unit of heat. This law is readily grasped, and is universally understood and admitted by engineers. The second law of thermodynamics is more simple for it merely states that heat always tends to pass from a hot body to a cold one, and never from a cold body to a hot one; but although it is indeed simple, its full consequences are by no means easy to trace out.

The "first law" has received a considerable amount of attention from writers on popular science, and was very clearly examined and discussed in Tyndall's book on "Heat Considered as a Mode of Motion." The "second law," however, has never been treated in the same way, so far as we are aware; and we are by no means sure that it could be so treated. Rankine pointed out the lack of popular information of this kind nearly thirty years ago.

The "second law" which, in it's simplest form, merely states that heat always tends to pass from a hotter body to a colder one, is far-reaching in its consequences. It was first proposed as a broad and universal principle of nature, by Lardner; and although numerous distinguished mathematicians and physicists have questioned its validity from time to time, it is now recognized as a great, universal truth, applicable without exception to all classes of phenomena. It is obvious enough in its simpler manifestations: every housewife knows that to make the kettle boil, she must put it on the stove, and not in the refrigerator. In less familiar cases, however, its truth is not always so obvious, and that is why it did not at first receive the general acceptance that has since been accorded to it.

We cannot undertake to trace out the results of the "second law" in this place. One of its important consequences, however, is that no engine could utilize all the heat that it takes in, even if it were absolutely perfect in workmanship and entirely free from friction, radiation, and other similar losses incident to all actual engines. There is a limit to the performance of every kind of heat-engine, which cannot be exceeded, however perfect its construction may be. In the case of a condensing steam engine, in which the drip from the condenser is returned to the boiler again, the greatest possible efficiency is expressed by the fraction

$$\frac{T-t}{T+460^\circ}$$

where T is the temperature of the boiler and t is the temperature of the condenser, both being expressed on the Fahrenheit scale. For example, let us suppose such an engine is using steam at 115 lbs., and that the back-pressure in the condenser is 2.9 lbs. The temperatures corresponding to these pressures are T — 347 deg. and t — 140 deg., respectively; and hence the greatest possible efficiency of such an engine is

$$\frac{347^\circ-140^\circ}{347^\circ+460^\circ}=\frac{207^\circ}{807^\circ}=.256$$

or 25.6 per cent. That is, we can build the engine as finely as we please, guarding against every conceivable kind of loss, and yet, so long as we run it under these conditions, it will never utilize more than 25.6 per cent of the heat supplied by the boiler; nor could we realize more than this, by using any other vapor in the place of steam.

A similar limitation is set by nature on every imaginable form of motor, which transforms heat-energy into mechanical energy. The thermo-electric battery, for example, is subject to just the same law as the condensing steam-engine. The thermo-electric battery, in its best known form, consists of a series of bars of bismuth and antimony, soldered together at their alternate ends, so as to form an electrical circuit. Every other junction (i. e. the first, third, fifth, seventh, etc.,) are heated, and the remaining ones (i. e. the second, fourth, sixth, etc.,) are cooled. Under these circumstances a part of the heat that is supplied to the hot junctions is transformed into electrical energy, and an electric current is obtained. This, in turn, may be used to operate an electric motor, and so, by a kind of roundabout process, we have heat-energy transformed into mechanical energy. If T represents the temperature of the hot junctions, and t that of the cold ones, the greatest possible efficiency of the apparatus (when considered as a heat motor) is given by the formula quoted above, just as in the case of the condensing steam engine. The efficiency may indeed be far less than the formula indicates, but it cannot, under any circumstances, be greater, no matter whether the thermo-electric arrangement is constructed of bismuth and antimony, as assumed above, or of any other substances. Inventors have spent a great deal of time and labor upon the improvement of the thermo-pile, which might have been saved and devoted to some more useful end, if the limitation imposed by the second law of thermodynamics had been properly understood.

The second law, as has been said, imposes a limit on the efficiency of every form of heat-motor. We cannot evade this limitation by superior modes of construction, for it is fixed by the very nature of heat. Any apparatus that first converts the chemical energy of the fuel into heat, and then transforms the resulting heat into mechanical energy, is necessarily subject to the law referred to; but if we could discover some method of obtaining mechanical energy from the fuel without the intermediate transformation into heat, the second law would no longer apply, and we could very likely devise a form of motor that would greatly exceed the steam engine in efficiency.

It is very likely that this problem is solved in the animal body, for here we find muscular force and mechanical work, derived, to all appearance, directly from the chemical energy that resides potentially in the highly organized tissues of the body. There is little or no evidence that the animal body is a heat motor. Mammals and birds are warm, it is true, but that is probably because requisite chemical changes cannot occur at a lower temperature. Frogs, fishes, worms, and molluscs are cold, and yet they can solve the problem too,—sometimes in most vigorous fashion. We know very little about the processes that go on in the muscular system. Further research will probably give inventors some valuable suggestions, but at present our knowledge of physiology is too slight to show us how to build a successful motor.

Leaving the animal economy out of account, the only other method that we know of, for transforming chemical energy into the mechanical form, without the intermediate use of heat, is afforded by the galvanic battery. This method is certainly full of promise, though so much thought has already been spent upon it that the present outlook is not so encouraging as it might be. The great difficulty with the galvanic method is, that heretofore every convenient and practicable form of battery consumes zinc, and zinc is too expensive to be of much use as a fuel. If we could only devise some feasible kind of a battery that would consume carbon instead of zinc, we should stand some chance, perhaps, of removing the steam engine from its present proud position. Numerous attempts of this kind have been made already. Twenty years ago, or more, a form of battery was devised by Jablochkoff, in which carbon was the substance consumed. The Jablochkoff cell does not pretend to be more than a scientific curiosity, but it isl nevertheless interesting.

"The liquid of this cell," says Niaudet, "is melted nitrate of potash or nitrate of soda; one electrode is of coke, and the other of platinum, or even of cast-iron. The coke is burned at the expense of the oxygen of the nitrate, and produces torrents of carbonic acid. The cast-iron remains unattacked. The coke (cast-iron?) is therefore the positive electrode, and the cast-iron (coke?) the negative. It is the contrary of that which would take place in a battery with an ordinary liquid, acid, or salt dissolved in water. The nitrate should be previously melted, but as soon as the action begins the salt remains liquid on account of the great heat produced by the combinations which take place; and if the element be left to itself it suffices, to put it in action, to bring the end of the coke to a glowing red heat, and then to press it against the surface of the salt. The chemical action begins immediately. . . . It might be found that such a battery cell presents nothing practical in its actual form, and we do not hesitate to express that opinion but we believe that it points out a new way in which much progress might be made if the attention of physicists were turned in that direction. Volta's battery itself, when invented, was a purely scientific novelty, and it was far from being regarded as an object of any practical utility."

The quotation here given will show that the idea of constructing a carbon-consuming battery is by no means new. We have no doubt that it was tried even

before Jablochkoff's time, but we have no record, at this office, of any earlier experiments. The latest attempt in this direction is due to Dr. Jacques, whose invention has attracted so much attention that a description of it in some detail may be of interest. Each cell consists of a cast-iron pot, which serves as a containing vessel, and at the same time acts as the positive electrode. The negative electrode consists in a stick of carbon, which is placed centrally in the cell. The iron cell is nearly filled with caustic soda or caustic potash, which is kept in a state of fusion by means of a furnace, from the interior of which a stream of air is blown into each cell at the bottom, and, is caused to bubble up through the liquid caustic by means of a sort of flat-shaped rose nozzle. The apparatus being constructed as described above, and connected up with wires, it is found that a considerable current of electricity can be obtained from it.

Dr. Jacques' theory of the cell seems to be, that the only function of the furnace is to keep the caustic melted; so that by jacketing the battery thoroughly the consumption of fuel in the furnace could be reduced so as to be relatively insignificant and unimportant. He appears to ascribe the electric current to the oxidation of the carbon rods in the cells, the oxygen needed for this oxidation being furnished by the air which is blown up through the molten potash. In the course of some tests carried out by Dr. Jacques and others with this idea in mind, the loss in weight of the carbon rods was compared with the output of electrical energy yielded by the battery, the result being that the apparatus showed an efficiency, in one case, of no less than 87 per cent. The fuel burned in the furnace, being supposed to be of minor importance for the reason stated above, was not estimated. The electromotive force of a single cell of the battery was found to be about nine-tenths of a volt. There is a strong similarity between Dr. Jacques' battery and the earlier form invented by Jablochkoff, the chief difference being that the oxygen is furnished by the electrolyte itself in one case, and by the steam of air bubbles in the other case.

If further experiment should substantiate the assumption of Dr. Jacques, that the electrical energy obtained from his battery is due solely to the oxidation of the carbon rods, there can be no doubt that the invention would be of the first importance; for although carbon rods are more expensive than ordinary coal, and the battery would be more likely to get out of order than a modern steam engine is, the wide margin of efficiency in favor of the new device would probably much more than compensate for these difficulties. But unfortunately such outside experiments as have been made do not justify the inventor's hypothesis at all. Mr. C. J. Reed, for example, has shown that the carbon rods act merely as conductors, and that they can be replaced by iron, brass, copper, German silver, or other metallic bodies, without detriment to the battery. He found, further, that the disintegration of the carbon rods is merely incidental, and that if good arc-light carbons are used, they do not suffer any sensible loss. He also found that the cell works much better and lasts much longer if the caustic potash is replaced by nitrate of potash, precisely as originally recommended by Jablochkoff. Finally, Mr. Reed found that illuminating gas may be substituted for the air, without lessening the electrical yield of the apparatus.

Mr. Reed's experiments establish the fact, beyond a reasonable doubt, that the source of the energy given off by the Jacques battery is the fuel that is consumed in the furnace below the pots. The device is not a galvanic battery at all, but a sort of thermo-electric apparatus, working on the same principle as the old bismuth-antimony arrangement, and subject to precisely the same laws. The chemical energy of the coal in the furnace is first transformed into heat, and then into electrical and mechanical energy. The significance of these words is great, for they show that Dr. Jacques has not evaded the second law of thermodynamics. His battery and motor constitute a true heat-engine, and are subject to the very limitations that fix the maximum efficiency of the steam engine.

We do not say that the new battery will not be useful. It is no small advance to construct a thermo-electric combination that can yield so large a voltage. and if the efficiency of a battery turns out to be as great as five or six per cent, it will doubtless be useful in many ways. But the ideal galvanic battery, which consumes carbon instead of zinc, is yet to be discovered.—The Locomotive.

Obituary

MONROE GREENWOOD.

It sometimes happens that occasions arise when a fraternal industry, forgetful for the time of the otherwise ceaseless strifes of competition, joins with practical unanimity in expressions of common feeling concerning events that are of mutual interest, whether the feeling evinced is of a direct or indirect nature or whether the occasion be one of rejoicing or sadness, hearts are moved by mutual impulse and the fellowships or kindnesses of human nature manifest themselves in the sympathetic signs of congratulation or of condolence, as is meet.

So it was that the electrical interests of the Pacific Coast with one accord were pained to learn of the death of Mr. M. Greenwood, not only for the intrinsic worth of his sterling manhood, but as well for the loss of the one who may fitly be termed the father of electrical enterprises on the Pacific Coast. Being a pioneer in "The days of Gold," his name stands above all others in the priority of electrical undertakings in the far West. Mr. Greenwood's long career of usefulness, terminated in his very sudden death in San Mateo, Cal., Oct. 11, 1896, of heart failure.

Monroe Greenwood came of an old New England family of English ancestry as the surname indicates. He was born in Dublin, Cheshire County, New Hampshire, where he was raised and educated and where his training was naturally that usual to most New England boys of the good old families. As a result of what he had read and heard of California, he came hither in February 1852. At that time, mining was the great industry of the State, and being among the thousands who went to the mines, Mr. Greenwood located on the American river where he spent about a year in mining, principally in 1853. He followed this avocation in all about three years, after which he located in San Francicso is a result of the firm conviction that this city was destined to become a great commercial mart.

The situation at that time was such as to lead Mr.

Greenwood to believe that the field of telegraphy in the far West was a most promising one, as a result of which he was engaged by the Western Union Telegraph company to build and take charge of the division of the overland telegraph line extending from Fort Churchill, Nev., to the Coast. This was a very important section of the line and a reflection of Mr. Greenwood's ability as a telegraph manager is found in the highly successful results both financial and electrical, which that enterprise shows. His next move was in the building and equipping of the fire alarm and police telegraph system of San Francisco, where for ten years until 1875 he occupied the position of superintendent of the fire alarm telegraph.

The invention of the telephone about this time at

MONROE GREENWOOD

once interested Mr. Greenwood who clearly foresaw the indispensible part that telephony must soon take in the business world and he resigned his San Francisco fire alarm superintendency in order to inaugurate electrical enterprises which he rightly believed would develop into valuable properties, and as a result of his work the district telegraph and telephone company was incorporated in March, 1875. On October 14th of that year, the business of the newcompany was well in hand under the general superintendency of Mr. Greenwood who held the position until July 28th, 1877 when it was relinquished for the treasurership. The electrical developments at that time were rapid in certain lines and most notable among the new enterprises inaugurated was the incorporation of the Gold and Stock Telegraph company on April 15th, 1878. In this company also, Mr. Greenwood was an active promoter and from the time of its inception he held the position of director and treasurer of the concern.

Among the other enterprises in which Mr. Greenwood was interested either as originator or as purchaser, were the various concerns that were consolidated by the articles of incorporation of the California Electric Works, dated 1877. By this consolidation the California Electrical Works succeeded to the business of the Electrical Construction and Maintenance company organized in 1868 and incorporated in 1870, the California Electric Power company, the Pacific Electro-Depositing Works, and the California Electric Gas Lighting Company, and as is well known now, the California Electrical Works stands to-day the largest and best equipped general electrical supply house on the Pacific Coast. Considering the fact, that with the exception of a very few months, Mr. Greenwood was president of the California Electrical Works from the date of its incorporation, it is evident that the business has been built up through his untiring perseverence and ability.

In this connection it is interesting to note that in 1870 the business of the Electrical Construction and Maintenance Company was located on the corner of Montgomery and Jackson streets, San Francisco. Mr. Geo. S. Ladd was president, while Mr. Stephen D. Field, whose name is now known in every part of the electrical world, was manager and electrician. In 1871 the company moved to 134 Sutter street where it remained until the concern was absorbed by the California Electrical Works.

About a year after the incorporation of the Gold and Stock Telegraph Company the probabilities of telephony had so expanded as to make it advisable that the telephone industry should, so far as possible, be under the control of a distinct corporation, with the result that the Pacific Telephone and Telegraph Company was then incorporated by Mr. Greenwood and associates, since which time Mr. Greenwood has been a director both in the Pacific Telephone and Telegraph Company and in the Sunset Telephone and Telegraph Company.

Personally Mr. Greenwood joined few societies or orders as his business interests and his love of home and family always took up the greater portion of his time. Throughout life he has been very conservative, and the electrical industry could not have had a more faithful and persevering worker than was to be found in the lamented Mr. Greenwood. His extensive interests will be well taken care of by his sons, George D., and Frederick A. Greenwood.

THE EFFICIENCY OF ELECTRICTY FOR TOOL DRIVING.

An English ship-building yard has installed an electric power plant for driving portable drills, cranes, wood deck planing machines, punching machines, fan blasts, etc., displacing steam power and effecting by the change a saving in the weekly consumption of coal of from 72 to 38 tons.

The Trade.

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

PLASTIC RAIL BONDS.

The difficulties that have long been experienced in the bonding of rails of electric railway systems to secure the best possible return circuit have led to the invention of various devices, none of which present more originality than that recently placed on the market by Harold P. Brown of New York, who in bringing out his Plastic Rail Bond has made a radical departure from all other methods heretofore followed in that the bond is composed of two portions: a plastic or putty-like metal compound which makes contact between the rail and the metal of the joint, and a flexible, elastic cork case to hold same in position, as near the end of about two inches in diameter on both rails and plates are cleared of rust and scale and treated with a solid alloy which instantly silvers the surfaces and prethrough a plastic band to the angle plate, thence through a second bond to the next rail. Contact spots the rail as possible. The current passes from one rail vents them from rusting. When properly applied the conductivity of the completed point is affirmed to be equal to that of the rail. The bond for a 9 inch rail, for instance, will carry 1,500 amperes with a drop of but 0.03 volts, while the best copper bond of $\frac{5}{8}$ inch rod has, even while new, more than 10 times this drop and its loss increases rapidly with time.

The accompanying table sets forth a series of rail bond resistance tests made by Mr. Franklin Sheble at the laboratory of the Cutter Electrical and Manufacturing Co. in Philadelphia, during September last. Standard Weston instruments were used throughout the test, and the varieties of bonds used in the respective tests are as follows, the number of bond appearing below, corresponding to the test number as given in table:

Test No. 1. Chicago Bond. 36 inches long, 0.4375 inches in diameter with a $\frac{1}{8}$ inch hole in the rail. The bond was smoking hot at the end of five minutes test.

Test No. 2. Columbia Bond. 24 inches long, 0,4375 inches in diameter, $\frac{1}{8}$ inch hole in rail. Sizzling hot at the end of 7 minutes test.

Test No. 3. W. Bond. 2.75 inches between centers, $\frac{3}{8}$ by 5-16 inch, one-half inch hole in rail. Scorching hot at the end of six minutes test.

Test No. 4. Johnston Bond. 20 inches long, 0.4375 inches in diameter, taper hole 13-16 and $\frac{3}{4}$ inch diameters. Very hot at the end of six minutes test.

Test No. 5. U. Bond. Laminated copper. 2.75 inches between centers, $\frac{3}{4}$ inch by 3-16 inch, $\frac{1}{8}$ inch hole in rail. Very hot at the end of seven minutes test.

Test No. 6. Nichol's Plastic Bond. Amalgamated Copper loop, 6 inch by 2 inch by $\frac{1}{8}$ inch on bottom of 90 lb. rail, with hollow receptacles in each end for plastic alloy. The bond was cold at the end of ten minutes test. Its carrying capacity equals 1 2-3 "U" or 4 Chicago bonds.

Test No. 7. Plastic Plug Bond. 60 lb. rail joint with one pair of $\frac{5}{8}$ inch holes through one angle plate only. Cold at end of 10 minutes test. The bond equals two "U" or five Chicago bonds.

Test No. 8. Plastic Bond on 60 lb. rail point under one angle plate only, cold at the end of 10 minutes test. The bond equals 2 $\frac{1}{2}$ "U" or six Chicago bonds.

Test No. 9. Plastic Plug Bond on 60 lb. rail joint with one pair of $\frac{5}{8}$ inch holes through two angle plates. Cold at the end of 10 minutes test. The bond equals 3 "U" or 7 Chicago bonds.

Test No. 10. Plastic bond on 90 lb. rail joint under one angle plate only. Cold at the end of 10 minutes test. The bond equals 3$\frac{3}{4}$ "U" or 9 Chicago bonds.

Test No. 11. Plastic Bond on 60 lb. rail joint under both angle plates. Cold at the end of 10 minutes test.

COPPER BONDS.

Test No.	100 Amp	200 Amp.	300 Amp.	400 Amp.	500 Amp.	600 Amp.	700 Amp.	800 Amp.	900 Amp.	1,000 Amp.	1,100 Amp.	1,200 Amp.	1,300 Amp	1,400 Amp.	1,500 Amp.
1	0.025	.05	.08	.10	.12	.16	.18	.20	.22	.24	.25	.32	.33	.34	.38
2	0.025	.05	.08	.10	.11	.135	.145	.18	.20	.23	.245	.26	.28		.34
3	.017	.035		.07	.084	.10	.12		.15	.175		.20		.24	.26
4	.01	.02	.03	.04	.05	.06	.07	.08	.09	.12	.132	.144	.156		.18
5	.01	.02	.03	.04	.05	.06	.07	.08	.09	.10	.11	.12	.13	.14	.15
6	.006	.012			.03	.035	.04	.05	.055	.06	.065				.09

PLASTIC BONDS.

7	.005	.01	.015	.02	.025	.03	.035	.04	.045	.05	.055	.06	.065	.072	.086
8	.004	.008	.012	.016	.02	.025	.03	.036		.04	.044	.048	.052		.06
9	.0045	.009			.017			.03	.032	.034	.038	.04	.042	.044	.046
10	.004	.008	.0085	.009	.0095	.01	.012	.013	.015	.017	.019	.02	.025	.03	.04
11	.003	.004	.0055	.0078	.0085	.01	.012	.013	.014	.019	.02	.024	.025	.028	.03
12	.0004	.0008	.001	.0016	.002	.0025	.0028	.0036	.004	.0045	.0048	.005	.006	.0062	.0064
13	.005	.01	.016	.022	.025										
14	.004	.008	.012	.016	.018	.024		.032	.036	.04					

Bond equals 5 "U" or 12 Chicago bonds. T.

Test No. 12. Plastic Cup consisting of a V-shape slot cut in the web of the rail at joint with steel cup holding plastic alloy. Cold at the end of 10 minutes test. The bond is beyond comparison with other bonds. T.

Test No. 13. Plastic socket of No. 000 amalgamated copper resting in holes in rail filled with plastic alloy. Tested with double its proper current and warm at the end of ten minutes, with 500 amperes. This bond was designed for 250 amperes and was cold at that load.

Test No. 14. Plastic sockets of 2 No. 0000 amalgamated copper strips resting in holes in rails filled with plastic alloy; as in test No. 13 this bond was tested with double its proper current and was warm at the end of 10 minutes, though cold at 500 amperes for which it was designed.

In making these tests all copper and steel contracts were absolutely bright and made in the best possible manner by the Cutter Electrical and Manufacturing Company. In the table the amperes given at the top of the columns represent the current transmitted while the figures given for each test record the drop in volts.

The plastic alloy is shipped in small wooden boxes; each box holds the exact amount necessary to make one contact between rail and angle plate. Each rail joint requires two such boxes. On heavy rails each box also holds one amalgamated spring washer which can be compressed to less than the minimum distance between web of rail and inner surface of angle plate. The cases to hold the plastic alloy are made of flexible cork, treated on the surface with a sticky compound; they will not deteriorate in service. To prevent their sticking together they are packed in waxed paper and powdered chalk and should be kept in a cool place until used.

In addition to the sphere of usefulness which flexible solder fills in making rail joints, it also presents unequalled advantages for use on contracts for bus bars, switch boards, dynamo terminals, etc., and the heating of switches can be stopped by amalgamating the blades and contacts and keeping same lubricated with the flexible solder. On the very best switches, the application of this material will show that the contact was previously made upon a few high points. After application it is evident there is a perfect surface contact.

Moreover, the application of a little flexible solder to main switches carrying heavy currents will demonstrate the existence of unsuspected station losses, and in this connection an interesting experiment can be made with a Weston milli-voltmeter by taking the drop in voltage with a given current on a given switch before and after applying flexible solder. If no millivoltmeter is at hand comparative readings that will be equally instructive may be taken by disconnecting the lead wires of a Weston ammeter from its shunt and applying them as with the milli-voltmeter.

The Pacific Coast agency for the Edison-Brown Flexible Solder or plastic rail bond has been placed with the Abner Doble Co. of San Francisco.

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Abbreviations: Illustrated (*); Editorial, (Ed.); Educational, (Educ.); Electro-Economics, (Elec-Econ.); Electro-Insurance, (Elec-Ins.); Electro-Therapeuty, (Elec-Ther.); Financial, (Fin.); Hydraulics, (Hyd.); Illumination, (Ill.); Literature, (Lit.); Metallurgy, (Met.); Mining, (Mi.); Passing Comment, (P. C.); Physics, (Phys.); Pneumatics, (Pneu.); Telegraphy, (Teleg.); Telephony, (Telep.); The Trade, (T.); Transmission, (Transm.); Transportation, (Transp.)

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